ROSETTA LANDER - IN SITU INVESTIGATION OF A COMET´S NUCLEUS. S. Ulamec[1], B. Feuerbacher[1], K. Wittmann[1], H. Rosenbauer[2], J. P. Bibring[3], D. Moura[4], R. Mugnuolo[5], and G. Haerendel[6], [1]DLR, Inst. f. Space Simulation, D-51147 Köln, Germany, e-mail: stephan.ulamec@europa.rs.kp.dlr.de, [2]Max Planck Inst. f. Aeronomy, D-37189 Katlenburg-Lindau, [3]IAS, F-91405 Orsey, France, [4]CNES, F-31055 Toulouse, France, [5]ASI, I-75100 Matera, Italy, [6]Max Planck Inst. f. Extraterr. Physics, D- 85740 Garching, Germany.

As part of the ESA cornerstone mission Rosetta to comet P/Wirtanen, there will be a lander with an overall mass of about 75 kg, provided by a of European research institutes. After arrival of the Rosetta main spacecraft at the comet and an extensive investigation of its nucleus for a suitable landing site, the Rosetta Lander will be ejected and descend to the comet´s surface. After touch- down, the lander will operate for several months and collect information on the surface properties of P/Wirtanen as a function of time and distance to sun. The selected complement of scientific instruments will determine the chemical, physical and mineralogical properties of the surface material, provide images and also investigate the internal structure of the nucleus.

Rosetta Mission

Rosetta (named after the stone of Rosetta, with which it was possible to decipher the Egyptian Hieroglyphs) is one of the cornerstone missions within the science program “Horizon 2000” of the European Space Agency (ESA). Its objective is the scientific characterization of an active comet. After launch in 2003, swingbys at Mars and the Earth and flybys at the asteroids Mimistrobell and Rodari, Rosetta will arrive at comet P/Wirtanen in 2011. The spacecraft will then go into an orbit around the cometary nucleus and deliver the lander in 2012, at a solar distance of about 3 AU [1].

Scientific Background and Lander Science Objective

Comets are believed to be the most primitive bodies in our planetary system, having preserved material from the early stages of its formation [2,3]. They consist of material that has been preserved in the Oort-cloud, far away from the sun since the formation of the solar system. Due to gravitational effects some of them get injected into orbits, that bring them closer to the sun (and the earth). Once they are in such an orbit, their surfaces may get processed because of the irradiation of the sun. By investigating a cometary nucleus one expects a better understanding of the formation of the solar system.

The scientific objectives of the Rosetta Lander can be comprised by [4,5]:

- The determination of the composition of cometary surface matter: bulk elemental abundances, isotopes, minerals, ices, carbonaceous compounds, organics volatiles - in dependence on time and insolation.
- The investigation of the structure, physical, chemical and mineralogical properties of the cometary surface: topography, texture, roughness, mechanical, electrical optical and thermal properties.
- The investigation of the local depth structure (stratigraphy), and the global internal structure.

The payload of the lander consists of nine instruments with a total mass of about 22.4 kg. There are two evolved gas analyzers (COSAC and MODULUS), an alpha-proton-x-ray spectrometer (APXS) and a gamma-ray spectrometer (CHAMPAGNE)(tbc) to analyze the composition of the surface material, an imaging system (including a microscope and an IR-spectrometer; ISIS/ROLIS), instruments to analyze the physical properties of the comet material (MUPUS, SESAME), a radiowave experiment to analyze the internal structure of the nucleus (CONSERT) and a magnetometer/ plasma-detector (ROMAP).

Lander System

The baseline concept of the Rosetta-Lander is a structure of reinforced carbonfibre material, a thermal control system using RHUs to guarantee long term operation*, solar cells to provide power, a telecommunications system, using the orbiter as relay to Earth and a central computer, serving all subsystems and the payload [6].

The structure consists of a ground plate, an experiment platform and a polygonal sandwich construction, the hood, covering a warm area and carrying the solar generator. All will be manufactured in high-modulus carbonfiber material. Most instrument electronics and subsystems will be underneath the hood. One part of the ground plate, however, will not be hidden under the hood, forming a “balcony” and providing space for external instruments and subsystems, like the drilling system or unfoldable sensors that have to get into direct contact with the comet surface (e.g. the APX-spectrometer).

The design of the thermal control subsystem is challenging, because the lander has to operate on a comet nucleus with unknown rotation period, in distances between 3 and 1 AU from the sun with temperatures of the environment in the range between 120 K and 350 K. Special effort has to be taken for thermal insulation to keep the temperature inside the lander in a range between -55^{o}C and +70^{o}C throughout the mission. All subsystems and payload elements requiring warm environment will be mounted on the thermally insulated experiment platform underneath the hood. To avoid freezing during night, the use of RHUs (radioactive heater units) is foreseen.*

To provide power for instruments and system, there will be solar arrays covering the hood of the lander. For supporting a first sequence of scientific experiments and for

* technical concepts, not relying on RHUs are currently under study

redundancy purposes, also primary batteries will be used. For the scientific instruments an average power of 4 W will be available during cometary day-time. Higher power demands can be covered with the batteries. Those allow also night-time operation.

The lander will be ejected from the main spacecraft after selection of an adequate landing area from an orbit, about 1-5 km above the surface of the nucleus. The actual descent strategy is highly depending on the (yet unknown) physical parameters of P/Wirtanen (like mass, shape and rotation period). Thus, a flexible landing concept, which allows the setting of the landing parameters interactively during the mission is required. Landing will take place on a tripod that includes a device that dissipates most of the impact energy and allows rotation of the main structure. At impact, the firing of a hold-down thruster and the shot of an anchoring harpoon will avoid rebounding from the surface.

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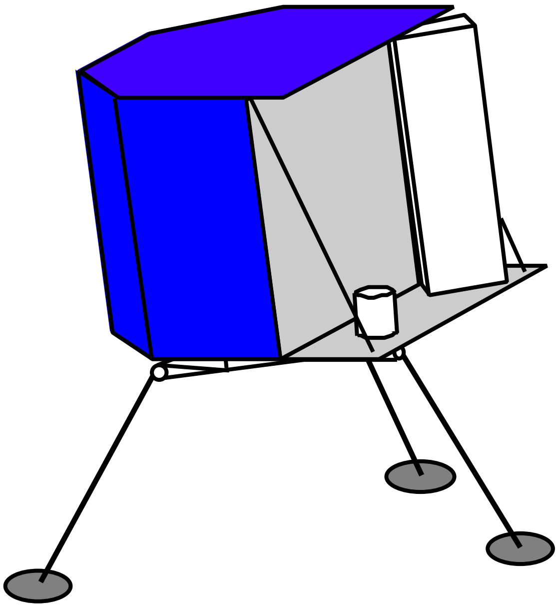

Figure 1: Sketch of Lander design